Journal of Applied Ichthyology

J. Appl. Ichthyol. 28 (2012), 590–596
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ISSN 0175–8659

Received: August 3, 2011
Accepted: January 28, 2012
doi: 10.1111/j.1439-0426.2012.01967.x

Shoreline distribution and parasite infection of black-striped pipefish *Syngnathus abaster* Risso, 1827 in the lower River Danube

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Summary

This study aimed to characterise the shoreline distribution and metazoan parasite community in black-striped pipefish *Syngnathus abaster* along the freshwater section of the River Danube (Bulgaria). An extensive survey of the shoreline zone showed the regular presence of *S. abaster* along the entire stretch from Vetren to Vrav (395–836 river km). The preference of shoreline habitat was analysed using abundance data and the proportion of this species in the fish community within particular habitat types. Highest frequencies of occurrence and density were found in sites with a muddy substrate, as compared to gravel and sand. A subsample of *S. abaster* from the upper section of the Bulgarian stretch was examined for metazoan parasites. The parasite fauna comprised eight metazoan species, representing half the parasite species richness known from its original range. Only three parasite species previously reported from *S. abaster* were found in the Danubian range of expansion: the adult trematode *Orientocreadium siluri*, metacercariae of *Diplostomum* sp., and an accidental finding of the trematode *Nicolla skrjabini*. The other five species appear to have been acquired in the new area, although these were recorded at a very low prevalence and ⁄ or abundance. *Syngnathus abaster*, therefore, is not likely to represent an important component in native parasite life cycles. Fish condition was not affected by either total parasite abundance or abundance of core species. Regular occurrence and dominance of *Syngnathus abaster* indicates that this species now represents a significant component of the Danubian shoreline fish community.

Introduction

In aquatic environments, expanding and introduced species represent an important component of many systems in fresh, brackish and marine ecosystems (Lavoie et al., 1999). Range extension of aquatic animals in inland waters may be facilitated among others by interconnection of river basins through man-made canals (Copp et al., 2005) or anthropogenic modification of habitat (Den Hartog et al., 1992). However, the species range extensions may have been limited in their extent by physical and biotic environmental barriers (Davis and Shaw, 2001). Regarding fish, such limits may be represented e.g. by salinity tolerance (Paavola et al., 2005) or dam constructions in rivers (Havel et al., 2005). The black-striped pipefish *Syngnathus abaster* Risso, 1827 (Syngnathidae), formerly denoted as *S. nigrolineatus* Eichwald (Karapetkova and Zivkov, 1995), is a euryhaline fish species inhabiting a wide range of marine, brackish and freshwater habitats (Kottelat and Freyhof, 2007). The original *S. abaster* distribution area includes coastal habitats and the lower reaches of rivers of the Caspian, Azov, Black and Mediterranean Sea basins, as well as the Atlantic coast from Gibraltar to the southern Bay of Biscay (Kottelat and Freyhof, 2007). During the 20th century, this fish species expanded its range upstream in the rivers Danube, Dniester, Dnieper, Don and Volga (Movchan, 1988; Bogutskaya and Naseka, 2002a,b; Cakić et al., 2002).

Syngnathus abaster was first reported in the Bulgarian section of the River Danube in 1982 (Karapetkova, 1994), and was still considered a rare species in the Bulgarian stretch of the Danube some years later (Karapetkova et al., 1998). During the years 1997–1998, this species was officially recorded in the Yugoslavian section of the Danube (Sekulić et al., 1999). Cakić et al. (2002) suggested that occurrence of *S. abaster* 900 km upstream of the river mouth was a result of introduction via ballast water transported in ships from the Black Sea region, whereby ballast water appears to be the primary vector responsible for transportation and introduction of aquatic organisms (Carlton and Geller, 1993; Grigorovich et al., 2003). Fish introduction via ballast water upstream the Danube River was suggested e.g. for the *Neogobius* species (Wiesner, 2005; Borcherding et al., 2011). Euryhaline species, such as *S. abaster*, are expected to have a higher probability of survival and establishment in a new area when transported in ballast waters (Lavoie et al., 1999). However, natural expansion of this species is also very probable. The continuous occurrence of *S. abaster* has recently been reported by Polačik et al. (2008) along the entire 500 river km shoreline zone of the Bulgarian Danube, from Vetren to Vrav (395–836 river km), although no data on fish abundance and habitat preference were presented.

As *S. abaster* is not an economically important fish species, data on its biology and ecology, especially in freshwater ecosystems, are still scarce (Baillie and Groombridge, 1996), with most studies focusing on reproductive biology (e.g. Berglund et al., 1986; Silva et al., 2006a,b). Habitat selection and spatial segregation of syngnathiid fishes have been investigated in marine ecosystems only (e.g. Kendrick and Hyndes, 2003; Malavasi et al., 2007). Similarly, the parasite fauna of *S. abaster* summarised in Gayevskaya et al. (1975) only includes studies from marine and brackish environments in its native range of the Black, Azov and Mediterranean seas. To our knowledge, no parasitological survey has thus been published on newly spread freshwater populations of *S. abaster*.

In this paper the main aims were (i) to analyse shoreline habitat preference along the freshwater Bulgarian section of

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the River Danube using *S. abaster* abundance data and proportion of this species in the fish community within particular habitat types; and (ii) to characterise the metazoan parasite community of *S. abaster* along the same stretch of the Danube, where this fish species now occurs at high frequency and thus represents a significant component of the local fish community (Polačik et al., 2008).

Materials and methods

During October 2005 and 2006, 47 samplings at 33 sites were sampled along the shoreline zone of the Bulgarian stretch of the River Danube (Fig. 1). Fish were sampled by beach seine net (7 m long, 4 mm mesh size), which was moved ca. 20 m downstream along the shoreline for each sampling, depending on substrate and access (for details see Polačik et al., 2008). During both seasons, the total stretch length sampled was 2.5 km. Fish density was calculated as catch-per-unit-effort (CPUE = number of fish per 100 m of shoreline, Zalewski, 1985), frequency of occurrence as the percentage of sampled sites with *S. abaster* presence, and proportion of *S. abaster* in the fish assemblage per individual sampling site. Substrate type was categorised as (i) mud, (ii) sand, (iii) gravel (if pebbles covered more than 75% of the sample area), and (iv) mixed substrate (sand–mud, gravel–mud, gravel–sand) if the proportion of both substrates was equivalent.

For parasitological examination, a subsample of 30 fish specimens was collected in the upper section of the Bulgarian River Danube (770–836 river km) during October 2006. Water temperature ranged from 16.5 to 18°C. Fish were transported live in river water to the field station in the town of Vidin. In the laboratory, the fish were individually sacrificed prior to dissection and examined under a binocular microscope for the presence of metazoan parasites according to standard protocols within 24 h of transport. Standard length (SL, to the nearest mm) and eviscerated (without internal organs) body weight (W to the nearest 0.1 g) were measured. Fish condition was calculated as Fulton's condition factor: $F = W*10^5/SL^3$. A representative subsample of fish with mean SL 10.5 cm (range 4.6–16.2 cm) was used for fish dissection. Weight-length relationship (Froese, 2006) was estimated from the data for parasitological examination.

Collected parasites were preserved in either 4% formaldehyde (Acanthocephala, Digenea, Cestoda), or a mixture of glycerine and alcohol (Nematoda). Prior to species identification, Acanthocephalan were cleared in clove oil, Nematodes were cleared in a glycerine-water solution and fixed digeneans and cestodes were stained in ferric acetocarmine (IAC), dehydrated in gradual alcohol series and mounted onto 'Canada' balsam (Ergens and Lom, 1970). Parasites were identified using a light microscope equipped with phase-contrast and differential interference contrast. After examination, the material was deposited in the Helminthological Collection of the Department of Botany and Zoology, Faculty of Science, Masaryk University Brno, Czech Republic.

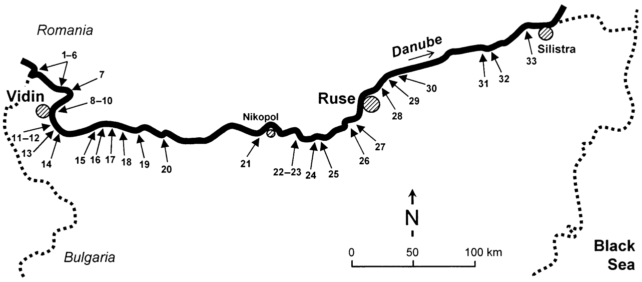

Fig. 1. Sampling sites on the lower stretch of the Danube River, Bulgaria. Numbers indicate locations referred to in Table 1

Ecological parameters of parasite infection were used according to Bush et al. (1997), with prevalence as the percentage of infected fish in a sample for a given parasite species and mean abundance as the mean number of parasites per host, infected and non-infected, in a sample. The classification of core and satellite species follows Hanski (1982), with core species as the locally abundant and regionally common species (prevalence $> 50\%$, mean abundance > 10), satellite species as locally and regionally rare species (prevalence $< 10\%$, mean abundance < 1) and parasites between the two groups classified as intermediate species.

The effect of habitat type on *S. abaster* density and proportion within the fish community was calculated using the Kruskal–Wallis test, and the effect of habitat type on *S. abaster* frequency of occurrence was tested using a generalised linear model (GLZ) with binomial distribution. Mixed substrate was excluded from the analyses due to the low number of samples. The relationship between parasite abundance and fish length (SL) and Fulton's condition factor (F) was tested using Spearman rank correlation. Prior to analysis, proportion data were arcsine$(x)^{1/2}$ transformed and parasite abundance data were $\log(x + 1)$ transformed. Statistical analyses were performed using STATISTICA 9.1, StatSoft, Inc, Tulsa, Oklahoma.

Results

Syngnathus abaster occurred regularly along the entire main channel of the Bulgarian stretch of the River Danube, although at a lower frequency between Oryahovo and Sandrovo (477–678 rkm). A total of 191 individuals was found, representing 3.7% of all fish collected in the shoreline zone. Presence of *S. abaster* was recorded at 26 of 47 sampling sites, fish density ranged from 0 to a maximum CPUE of 47.5, found at Yasen (825 rkm). Fish standard length ranged from 4.6 to 16.2 cm, with mean ± SD 10.7 ± 2.8 cm. A log-log plot of weight-length relationship with regression line (n = 30; $r^2 = 0.9796$) is shown in Fig. 2. The proportion of *S. abaster* at particular sampling sites ranged from 0 to 36% of the fish assemblage (Table 1). Significant differences were observed in *S. abaster* CPUE (Kruskal–Wallis test, $H(2,43) = 7.72$, $P = 0.021$, followed by multiple comparison test; Fig. 3a) and frequency of occurrence (GLZ, $\chi^2 = 6.91$, $P = 0.032$) for different substrate types, with muddy substrates as the most preferred habitat. No relationship was found between the substrate and proportion of *S. abaster* within the fish community (Kruskal–Wallis test, $H(2,43) = 1.58$, $P = 0.45$; Fig. 3b).

Parasitological examination documented the presence of eight metazoan parasite species/taxa. Only one species parasitised *S. abaster* at the adult stage, other species being found as larvae or subadults. All metazoan parasites were endoparasites; no ectoparasitic species were recorded (Table 2). Mean parasite abundance was 13.5 and overall prevalence 83.3%. The infracommunity richness ranged from one to four. Core species were represented by two taxa: subadult and adult examples of the trematode *Orientocreadium siluri* located in the intestine, and a larval trematode (metacercariae) Cyathocotylidae fam. sp. located in a variety of the fish host's organs. Two parasite taxa were classified as intermediate species: larval trematode (metacercariae)

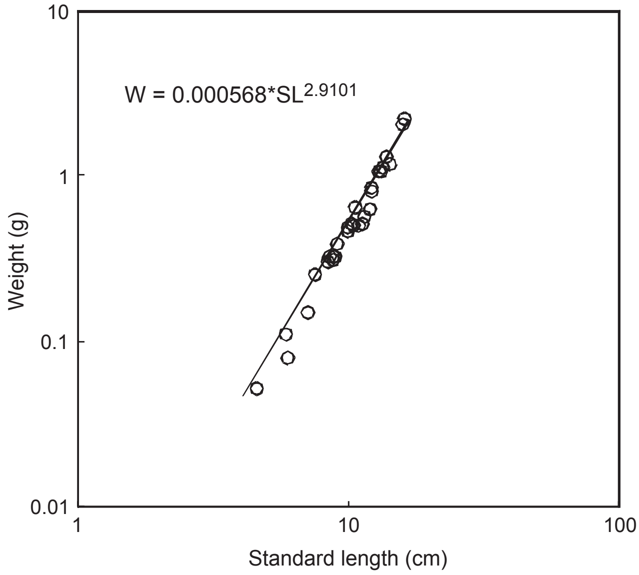

Fig. 2. Double-logarithmic plot of length-weight relationship of *S. abaster* from the Bulgarian stretch of the Danube River

Diplostomum spp. located on the eye lens, and subadult acanthocephalan *Pomphorhynchus laevis* located on the surface of the intestine and swim bladder. Four species occurred only sporadically and were classified as satellite species: two larval trematodes, *Echinochasmus perfoliatus* located in the head or gills and *Metagonimus* sp. located in the muscle tissue; larval cestodes *Proteocephalus* sp., encysted in the intestinal wall; and larval nematodes, for which more exact determination was not possible (Table 2).

The mean total parasite abundance and the abundance of core species (*O. siluri* and Cyathocotylidae fam. sp.) were not associated with fish length (Spearman rank correlation; $r_s = -0.12$, P = 0.53; $r_s = -0.23$, P = 0.23; $r_s = -0.002$, P = 0.99; respectively) or condition factor ($r_s = -0.004$, P = 0.98; $r_s = -0.04$, P = 0.85; $r_s = 0.14$, P = 0.48, respectively).

Discussion

The first report on the occurrence of *S. abaster* in the Bulgarian freshwater section of the River Danube was published by Karapetkova (1994), who found two specimens near the town of Silistra (376 rkm) in 1982. By the late 1990s, the species was recorded in the Yugoslavian stretch up to 956 rkm (Sekulić et al., 1999), although its occurrence in the Danube was reported as rare at the time (Karapetkova et al., 1998; Sekulić et al., 1999). An extensive survey of the shoreline zone upstream of Silistra during 2005 and 2006, however, showed relatively high densities and frequency of occurrence (Polačik et al., 2008; this study). Our data also demonstrate that this species can be found more or less regularly along the entire Bulgarian stretch of the River Danube from 395 to 833 rkm (Table 1). Cakić et al. (2002) suggested that *S. abaster* had been introduced with ballast water, which implies that its distribution should be intermittent or of an irregular nature. As we found a continuous distribution along the examined river stretch, however, our data points to natural dispersal upstream, or a combination of accidental introduction followed by natural expansion.

In marine environments, syngnathiid fish occupy either the seagrass canopy or reside at the sediment-water interface (Kendrick and Hyndes, 2005). Habitat structure along the shoreline of the lower Danube consists mainly of mud and stones with limited vegetation, especially during the autumn months when the water level is lower than in spring (Polačik et al., 2008). In the Danube, the highest density of *S. abaster* was found in muddy habitats. Malavasi et al. (2007), who observed a preference by *S. abaster* for proximity to the bottom in the seagrass canopy, explained their findings through the feeding strategy of the fish. The cone shaped snout of *S. abaster* allows it to capture smaller prey than, for example, *S. typhle* Linnaeus, 1758, which has a longer and higher snout that enables it to catch both faster and larger pelagic prey (Franzoi et al., 2004). Due to the limited vegetation along this stretch of the Danube, therefore, muddy habitats with a slow current represent the most suitable environment for *S. abaster*, probably due to its foraging strategy.

Parasite infections are recognised as one stress factor that may lower a host's ability to adapt to changing environmental conditions (Williams and Jones, 1994). Despite inhabiting freshwaters with a muddy substrate and low vegetation, in contrast to their native marine environment (Kendrick and Hyndes, 2003), all sampled *S. abaster* were in good condition. Moreover, our results showed no relationship between fish condition and parasite infection, probably due to the relatively low intensities of infection having a negligible impact on the fish. Similarly, no difference in Fulton's condition factor was found in introduced populations of *S. abaster* along the Serbian stretch of the River Danube or in native populations from the Black and Azov seas (Cakić et al., 2002). However, despite that no effect of parasite infection on the condition factor was found in this study, the potential effect of some parasite species might be applied in behavioural traits involved in pipefish reproduction, as shown by e.g. Rosenquist and Johansson (1995) or Mazzi (2004) on the deep-snouted pipefish *Syngnathus typhle*.

Parasite species richness of *S. abaster* in its native range, which includes the Azov, Black and Mediterranean seas and the lower reaches of adjacent rivers, comprises 17 metazoan parasite species (see Table 2), although none of the parasites are specific to pipefish (Butskaya, 1952; Koval, 1959, 1973; Gayevskaya et al., 1975). This is more than twice that found in our study, where only eight generalist species were registered. Loss of parasite species during the introduction/expansion process is a well-known phenomenon, important for successful establishment in a new area (Torchin et al., 2003). On the other hand, introduced/expanding species tend to acquire local parasite fauna, although the local parasites are often less effective at infecting the new host species (Cornet et al., 2010). Of the 17 parasite species known within the native range of *S. abaster*, only one, the trematode *O. siluri*, was definitely found to also parasitise *S. abaster* in freshwater environments (possibly also the diplostomid metacercariae infecting the eye lens and the accidental finding of *N. skrjabini* in the pipefish's mouth). This extensive reduction in parasite species richness may be associated with the low salinity tolerance of native pipefish parasites. Whilst some species are known from marine, brackish or freshwater environments (e.g. *N. skrjabini*, *O. siluri* or *Diplostomum* sp.), others appear to parasitise marine fish hosts only (Gayevskaya et al., 1975). Pipefish expanding into freshwater habitats, therefore, have an advantage due to reduced parasitism, as most of their native parasites are not adapted to low salinity.

Orientocreadium siluri, a native parasite of the *S. abaster* intestine, was the only species found at an adult stage, as well as the parasite with highest prevalence. So far, this trematode

Table 1
Sampling sites with location numbers shown on map (Fig. 1): river km, sampling year, substrate type, species in the fish community, total fish density and *S. abaster* density (in CPUE – number of fish per 100 m of shoreline) and proportion (%) within the fish community. *S. abaster* sites indicated in **bold**

Site No.	Location	Year	River km	Substrate	Fish species	CPUE total	CPUE (*S. abaster*.)	Proportion of *S. abaster* (%)
1	Vrav (+)	2006	836	Gravel	EL,AA,PF,NG	26.7	–	–
2	**Novo Selo**	2005	833	Gravel	EL,AA,AU,LI,SA,PF,NF,NG,NM,PS	193.2	10.9	5.6
		2006		Gravel	AA,PF,NF,NG,NM	20.0	–	–
3	**Florentin**	2005	827	Gravel	EL,AA,RR,VV,SA,PF,NF,NG,NM	121.7	2.8	2.3
4	**Yasen**	2005	825	Gravel	EL,AA,LI,RR,VV,C,SA,PF,NF,NG,NK,PS	371.2	12.3	3.3
		2006		Gravel	AA,LI,PF,NF,NG,NM	61.3	–	–
		2006		Mud[a]	EL,AA,AB,CA,SA,PF,NF,NG,NK,NM	607.5	47.5	7.8
5	**Gomotartsi 2**	2005	818	Sand	EL,AA,SA,PF,NF,NM,PS	134.5	12.7	9.5
6	**Gomotartsi 1**	2005	817	Gravel	AA,SA,PF,NF,NM	140.0	16.0	11.4
		2005		Mud	AA,BJ,LI,RR,SA,NF	146.7	20.0	13.7
		2006		Gravel	EL,AA,SA,PF,NF	86.7	8.3	9.6
7	**Koshava**	2005	811	Gravel	AA,SA,PF,NF	71.5	20.0	28.0
		2006		Gravel	AA,LI,GC,PF,NF,NG,NM	83.1	–	–
8	Vidin 2 (+)	2006	796	Sand	AA,AB,AU,LI,GS,BS,NF,NG,NK,NM,PS	131.3	–	–
9	**Vidin, side arm**	2006		Sand[a]	AB,LI,SA,PF,SL,NF	61.7	8.3	13.5
10	Vidin 1 (+)	2005	791	Gravel	AA,BB,GB,NF,NM	147.1	–	–
		2006		Gravel–mud	AA,NF,NG,NM	46.2	–	–
11	**Tsar Simeonovo 2**	2006	778	Mud	AA,AB,SA,NF	120.0	20.0	16.7
12	**Tsar Simeonovo 1**	2005	776	Gravel–mud	EL,AA,AB,AU,LI,RR,SA,PF,SL,NF,NG,NK,PS	281.2	15.9	5.7
		2006		Gravel	EL,AA,CA,SA,PF,NF	41.7	15.0	36.0
13	Botevo (+)	2006	774	Gravel	AA,RR,LG,PF,NG,NM,PS	71.7	–	–
14	**Archar**	2005	770	Mud	AA,AB,AL,LI,RR,SA,PF,NF,NG	296.4	24.1	8.1
		2006		Gravel	EL,AA,AU,C,LG,PF,NF,NM,PS	207.1	–	–
		2006		Mud	NF,NM	77.5	–	–
15	**Lom**	2005	744	Mud	EL,AA,AB,AU,BJ,LI,RR,C,SA,PF,NF,NG,NK,NM,PS	770.3	37.5	4.9
16	**Dolno Linevo**	2005	735	Gravel	EL,AS,AU,CN,SA,PF,SL,NF,NK,PS	95.4	15.4	16.1
17	**Stanevo**	2005	724	Mud	EL,AA,AB,AS,AU,LI,PP,RR,C,SA,LG,PF,SL,NF,NG,NK	393.3	11.7	3.0
18	Dolni Tsibar	2005	718	Sand–mud	AA,AS,RR,PF,NF,NK,NM	178.4	–	–
19	**Kozloduy**	2005	701	Mud	AA,AU,BJ,LI,RA,RH,RR,C,SA,LG,PF,SL,BS,NF,NG,NK,NM,PS	659.3	8.9	1.3
20	Oryahovo	2005	678	Sand	AA,LI,RR,RA,GS,PF,SL,NF,NG,NK,NM	99.3	–	–
21	Nikopol	2005	597	Sand	AA,PP,RA,PF,SL,BS,NF,NK	64.1	–	–
22	Belene – Hisarlaka	2005	578	Gravel–sand	AA,VV,GS,PF,SL,NF,NK,NM	127.1	–	–
23	Belene	2005	573	Gravel	AA,AU,CA,RA,VV,GS,PF,SL,NF,NK,NM	302.9	–	–
24	**Svishtov**	2005	555	Gravel	EL,AA,AS,BB,LI,VV,GS,SL,NF,NK,NM	225.7	–	–
		2005		Mud	AA,SA,NF	586.7	20.0	3.4
25	Vardim	2005	546	Gravel	EL,AA,AB,VV,C,RA,PF,SL,NF,NK,NM	163.9	–	–
26	Batin	2005	526	Mud[b]	AA,AU,LI,RR,GH,SL,BS,NF,NK,NM	342.3	–	–
27	**Mechka**	2005	516	Gravel	AA,AB,AU,PP,VV,GA,SA,GS,SL,NF,NK	400.0	20.6	5.2
28	Marten	2005	482	Gravel	AA,NF,NK,NM	42.4	–	–
		2005		Sand	RA,NF,NK,NM	60.1	–	–
29	Sandrovo	2005	477	Gravel	AA,CN,C,RA,GB,GS,PF,SL,BS,NF,NK,NM	187.1	–	–
30	**Ryahovo**	2005	466	Sand	AA,AS,RA,GH,SA,SL,BS,NK,NM	105.4	3.6	3.4
31	**Dunavets**	2005	423	Mud	AA,AB,BJ,RR,C,SA,LG,GS,PF,SL,BS,NF,NK,PS	176.7	1.7	0.9

Table 1
(Continued)

Site No.	Location	Year	River km	Substrate	Fish species	CPUE total	CPUE (*S. abaster*.)	Proportion of *S. abaster* (%)
32	**Dolno Ryahovo**	2005	418	Gravel	EL,AA,AU,CN,C,SA,LG,GS,SL,BS,NF,NK	136.7	10.2	7.5
		2005		Mud	AA,AU,C,SA,LG,SL,BS,NF	221.7	17.4	7.8
33	**Vetren**	2005	395	Gravel	AA,RA,SA,SL,NF,NG,NK,NM	145.0	15.0	10.3
		2005		Mud	AA,C,RA,SA,LG,GS,BS,NF,NG,NK,NM	521.1	2.6	0.5

(+) *S. abaster* sites documented by Polačik et al., 2008 (different sampling method and season).
AA, *A. alburnus*; AB, *A. brama*; AS, *A. sapa*; AU, *A. anguilla*; BB, *B. barbus*; BJ, *A. bjoerkna*; BS, *B. stellatus*; C, *Cobitis* sp.; CA, *C. auratus*; CN, *C. nasus*; EL, *E. lucius*; GA, *G. aculeatus*; GB, *G. baloni*; GC, *G. cernuus*; GH, *G. holbrooki*; GS, *G. schraester*; LG, *L. gibbosus*; LI, *L. idus*; NF, *N. fluviatilis*; NG, *N. gymnotrachelus*; NK, *N. kessleri*; NM, *N. melanostomus*; PF, *P. fluviatilis*; PP, *P. parva*; PS, *P. semilunaris*; RA, *R. albipinnatus*; RH, *R. amarus*; RR, *R. rutilus*; SA, *S. abaster*; SL, *S. lucioperca*; VV, *V. vimba*.
[a]Presence of submerged vegetation.
[b]Presence of woody debris.

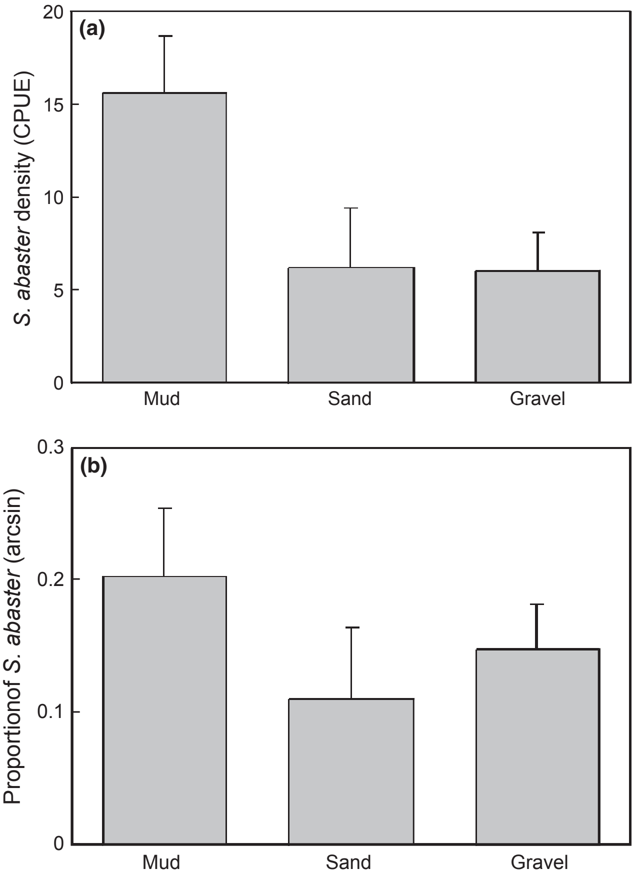

Fig. 3. Mean values + SE of (a) density (in CPUE – number of fish per 100 m of shoreline) and (b) proportion in fish community (in %) of *S. abaster* in mud (N = 13), sand (N = 7) and gravel (N = 23) substrate types

has been recorded in several fish host species in the Black, Caspian, Azov and Aral sea basins. In the Black Sea basin, *O. siluri* has been found in European catfish *Silurus glanis* from the rivers Dniester, Seversky Donets and Danube, and in *S. abaster* in the lower Dnieper (Koval, 1973; Gayevskaya et al., 1975). In contrast to our results, prevalence and abundance was relatively low in all *S. glanis* and *S. abaster* in the lower Dnieper (Koval, 1959) and in *S. glanis* in the lower Danube (Kakacheva-Avramova, 1977). Nevertheless, higher prevalence in some parasite species found in the new range is not rare (summarised in Torchin et al., 2003), although this usually appears in the early stages of colonisation and tends to diminish with time.

In relation to the local ecosystem, introduced ⁄ expanding species may also serve as a reservoir for one or several parasite species native in the host's new range (Tompkins and Poulin, 2006). Five species found in this study were acquired in the Danube. The infection parameters in the majority of these species were very low, however, indicating accidental infection rather than new host-parasite associations, probably due to the lack of a coevolutionary history with local parasite species (Torchin et al., 2003). Only two species were found at higher prevalence: acanthocephalan *P. laevis* complex and metacercariae of the Cyathocotylidae fam. sp. Both parasite species groups are generalists known from a number of other host species in the lower Danube (Kakacheva-Avramova, 1983; Nachev et al., 2010; Ondračková et al., 2010). The relatively low intensities of infection suggest that *S. abaster* does not represent an important component in parasite life cycles in this

Table 2
List of *S. abaster* parasites from its native range (including marine and brackish waters of the Black, Azov and Mediterranean seas) and prevalence (%) and abundance ±SD (in parentheses) of parasite species found in the Lower River Danube

Parasite species	Stage	Native range	Lower Danube
Digenea			
Acanthostomum imbutiformis	Adult	–[a]	
Acanthostomatidae fam. sp.	Metacercaria	–[a]	
Apopodocotyle atherinae	Adult	–[a]	
Bucephalus sp.	Metacercaria	–[a]	
Cryptocotyle concavum	Metacercaria	–[a]	
Nicolla skrjabini	Adult	–[a]	4 (0.1 ± 0.2)
Cyathocotylidae fam. spp.	Metacercaria		68 (11 ± 25.6)
Diplostomum spp.	Metacercaria	–[a]	36 (0.6 ± 1.0)
Echinochasmus perfoliatus	Metacercaria		4 (0.8 ± 4.1)
Metagonimus sp.	Metacercaria		8 (0.2 ± 0.8)
Orientocreadium siluri	Adult	–[a]	72 (3 ± 3.5)
Plagioporus sp.	Adult	–[a]	
Tetracotyle sp.	Metacercaria	–[a]	
Cestoda			
Proteocephalus sp.	Larva		8 (0.1 ± 0.3)
Scolex pleuronectis	Larva	–[a]	
Tentacularia sp.	Larva	–[a]	
Nematoda			
Nematoda gen. sp.	Larva	–[a]	8 (0.1 ± 0.3)
Contracaecum microcephalum	Adult	–[a]	
Acanthocephala			
Acanthocephalus incrassatus	Adult	–[a]	
Pomphorhynchus laevis complex	Subadult		16 (0.4 ± 0.9)
Copepoda			
Ergasilus nanus		–[a]	
Ergasilus ponticus		–[a]	

[a]Records from Butskaya, 1952; Gayevskaya et al., 1975.

freshwater stretch of the Danube. The low prevalence and ⁄ or abundance of most acquired parasites also indicate that these new host-parasite associations probably do not play an important role in local parasite population dynamics.

Acknowledgements

This study was supported by Centre of Excellence Project No. LC 522 (Ichthyoparasitology). We would like to thank the staff of the Regional Departments of the Bulgarian Agency of Fisheries and Aquaculture in Vidin and Ruse, and especially their Chiefs, Milen Metodiev and Atanas Mindev, for cooperation and support during fieldwork. We also thank Milen Vassilev, Martina Dávidová, Kateřina Francová, Zdenka Valová, Radim Blažek and Markéta Dušková for field assistance and help with parasite dissections.

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